ClimAG-Krigger: A New (Paleo)Climatology-Oriented Toolbox for Anisotropic Global Kriging Interpolation

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Abstract

Data-model comparisons are common when addressing (paleo)climate questions. Many applications require deriving continuous surface fields of scalar variables from a set of irregularly distributed data points, typically for model validation against data or data-derived model input as initial or boundary conditions. While various interpolation techniques and interfaces exist, few can simultaneously: (1) interpolate across local to global spatial scales, (2) perform anisotropic interpolation using the spatial structure derived from the data instead of an assumed one, and (3) explicitly derive uncertainty in the interpolated fields due to both data density and measurement error. We present a standalone interpolation toolbox including a graphical user interface (GUI), which is aimed at the general earth science community. It uses a kriging algorithm whose distance metric is the geodesic on an oblate spheroid, be it the WGS-84 reference ellipsoid for applications on the surface of the Earth, or an equivalent ellipsoid with varying radii for interpolation on vertical levels above the surface. While kriging algorithms exist that perform interpolation on such non-Euclidean distances, they do not provide a check for conditionally negative semi-definiteness (CNSD) of the variogram matrix, which is a requisite for the kriging method. Since mathematical theory of kriging on spheroids or ellipsoids has not yet provided a set of authorized variance-distance functions, we incorporated a numerical check for CNSD condition for each data realization and variance-distance modeling scheme. The GUI will allow the user a high degree of customization. Preliminary results are promising, with robust results for isotropic interpolation. The derivation of CNSD variogram matrices for anisotropic interpolation remains the major challenge of the project. When completed, ClimAG-Krigger will provide the community with an easy-to-use, robust tool for anisotropic global kriging that will be specifically tailored for (paleo)climate applications.

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